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## **Prognosis of Equine Limb Fractures Based on Type and Location**

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ROCHESTER INSTITUTE OF TECHNOLOGY

A Thesis submitted to the Faculty of  
The College of Health Sciences & Technology  
In Candidacy for the Degree of  
MASTER OF FINE ARTS  
In  
Medical Illustration

PROGNOSIS OF EQUINE LIMB FRACTURES  
BASED ON  
TYPE AND LOCATION

By  
Megan Gaffney  
January 14, 2018

Prognosis of Equine Limb Fractures  
Based on  
Type and Location

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## **ABSTRACT**

Horses are powerful animals: a galloping horse's forefoot hits the ground with an average of about 2,000 pounds of force. This can result in many kinds of injuries. To work with and love a horse properly, the owner needs to understand more than just grooming and feeding. Owners must understand how the horse operates, particularly the structure and workings of the horse's legs, to comprehend how a broken leg impairs a horse. This understanding enables the owner to work well with a veterinarian in determining the best course of treatment for an injury.

A review of the current veterinary literature and public resources showed that illustrated information regarding types of limb fractures in horses, options for repair and post-operative outcomes, that can be easily understood by the lay person, do not exist. The lack of sufficiently illustrated resources covering this topic indicates a great need for this valuable information.

The objective of this thesis is to illustrate common types of fractures, to assist owners in understanding different types of fractures, repair options, and possible outcomes of any intervention. Three cases, each with a specific type of fracture, were analyzed to develop understanding of the damage, the impact on the horse and surgical options versus the need for euthanasia. The finished product of this research was two posters, one for repair and the other for euthanasia, designed to enhance the owner's comprehension of the injuries.

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## **Introduction**

Horses are majestic and powerful animals but can often be unpredictable when ridden. To work with and love a horse properly, the owner needs to understand more than the basics of grooming and feeding a horse. The owner must understand how the horse functions, both physiologically and mechanically, through its body parts: how they relate to each other and how to care for them. An understanding of the horse's leg structures and how they work is also crucial to comprehending how impairing a broken leg can be for a horse. Parts of the equine bones can be very tough, but fractures do happen. For example, a galloping horse's forefoot hits the ground with an average of about 2,000 pounds of force.<sup>1</sup> This presents frequent opportunity for severe injury. Horses are used for many purposes, ranging from heavy-duty labor to pleasure as well as competition, and having faultless leg conformation is a critical part of movement. Without proper leg configuration, horses are useless.

The purpose of this thesis is to illustrate the anatomy of the horse's legs, common types of fractures, and possible outcomes so owners can make an informed decision regarding care should they be faced with this dilemma. This thesis was created in collaboration with a veterinarian, and visual materials were designed to assist owners in understanding types of fractures and repair options.

At times, horse owners may face a situation where a horse sustains a fractured or broken leg. Assuming there is no alternative, the owners frequently decide to end the horse's life. However, a fractured or broken bone does not always have to end in euthanasia. For owners to make informed decisions regarding repair versus euthanasia, they must have accurate information. The most common source of information is the veterinarian's guidance reinforced by the use of x-rays to explain the type of fracture and

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<sup>1</sup> Christy M. West, "Horse Hoof Anatomy: A Guided Tour," *The Horse: Your Guide to Equine Health Care*, published January 1, 2010, <http://www.thehorse.com/articles/24910/horse-hoof-anatomy-a-guided-tour>.

means of repair, if it is an option. It can be difficult for the owner to understand an x-ray, even with the guidance of the veterinarian.

Is there a better, more visual way to explain the types of fractures and the options for repair? One that would be more readily understood by a lay person and allow them to be better informed? A review of the literature, including CINAHL, Medline, PubMed, Web of Science, and public resources showed that illustrated information on limb fracture types in horses and options for repair and post-operative outcomes — information designed to be easily understood by a lay person — does not exist.

The goal of this thesis is to address this deficit and offer illustrations of the most common equine leg fractures designed to provide the owners insight so they can understand the veterinarian's evaluation, to ask pertinent questions, and then make a well-informed decision.

The availability of 3D graphics could help owners interpret information presented in the x-rays of the injury. The 3D graphics provide more detailed visual information allowing owners a fuller understanding of the implications of the injury and its impact on the horse's future. It is crucial to explain the diagnosis and the prognosis, which could also be more effective using 3D graphics. A visual representation of both the injury type and possible surgical repairs may grant owners peace of mind and help them feel they made the correct decision for their horse.

Illustrations also help owners visualize how a horse's legs contribute to their motion, identify the bones of a leg, list common types of fractures and their possible repair, and provide a decision tree for choosing a treatment option. This project used modern illustrative techniques to present information in a format that is accessible to a lay public.

Trying to make a decision between euthanasia and attempting repair can be an emotional and stressful time for an owner. Educational posters need to be simple, clear, and easy to read while providing critical information. The veterinarian and trainer could

use these posters to identify bones involved in the horse's injury, since the posters would illustrate this information in an easy-to-understand fashion.

### **Need for Illustrations**

There are many available resources to support my thesis, but there are not many illustrations available of a horse's broken legs with an explanation of leg fixation. For example, *Clinical Anatomy of the Horse* and *The Equine Distal Limb* have only photographs of skeleton preparation, dissection, and endoscopic views as well as images obtained by radiology, ultrasonography, and computerized tomography. The second edition of *Textbook of Veterinary Anatomy* has line illustrations of equine anatomy but contains no photographs or illustrations of fractured legs to aid horse owners in understanding the anatomy and ramifications of such injuries. The general veterinary library, online textbooks, and search engines such as Web of Science do not contain illustrations of broken bones translated from x-ray films. Most of these resources are also not accessible to the lay public.

Illustrations of healthy and broken bones in 3D have not been utilized in horse anatomy resources. X-rays showing broken legs are commonly found, but because they are rendered in shades of gray and 2D, they do not provide enough contrast and context for the owner to clearly see what has happened. Very often, fractures on an x-ray are not visible to a person not trained in reading x-rays, and when added to the fact that veterinarians typically use multiple x-ray views, this prolongs and complicates the explanation of the injuries to the owner. Having the bones and their breaks illustrated in 3D provides a more realistic view of a healthy bone in contrast to an injured bone.

## **X-Rays**

“X-rays are an integral and repetitive part of the diagnostic evaluation of veterinary patients. Good quality images are crucial to allow for correct interpretation.”<sup>2</sup> However, x-rays are only a two-dimensional representation of a three-dimensional object in a format that shows as a negative image. Multiple views are required to get a sense of the injury. The denser the object being x-rayed, the brighter/lighter the object will appear on the film. Further, the quality of the x-ray determines the reliability of the interpretation and the diagnosis.<sup>3</sup> Interpretation is also influenced by the skills of the radiologist who reads the x-rays. This skill is developed through the repetitive visualizing of films and is difficult to learn other than through experience. The veterinary radiologist is familiar with their patients, their anatomy, and their injury patterns, which helps in the interpretation, diagnosis and correct treatment choices for the animal. Using x-ray films to explain horse injuries and treatment options to lay people is very difficult, since they do not have the background to interpret the images.

Veterinarians interpret radiographic images to help owners understand the type and severity of the trauma when a bone is fractured. Veterinarians have to take five views of the structure since “radiographs are two-dimensional images of three-dimensional objects and interpret the three-dimensional object appropriately.”<sup>4</sup> These images reflect the amount of electromagnetic waves absorbed by the various tissues with the densest tissue (bone) showing as white and the supporting muscles and tissues as grey and less defined.

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<sup>2</sup> Diagnostic Imaging Systems, “Radiology Continuing Education Series,” Introduction. accessed February 22, 2011, <http://vetxray.com/resource-center/continuing-education/>.

<sup>3</sup> Equine Medical Service, “Radiographs—Why Bother With Those Pictures?” accessed October 25, 2012, <http://emsvet.com/newsletters/musculoskeletal/radiographs.html>.

<sup>4</sup> Ibid.

Radiographs contain information about bone only as it contrasts with the surrounding tissue and indicates where and what type of fracture has occurred. They help the veterinarians predict how the patient will respond to therapies, such as rest, immobilization, surgery, steroid injection or hyaluronate injections.<sup>5</sup> In x-ray films,

Broken bones have black lines through them where bone should be all white to gray in color. Some places where there is superimposition of soft tissue over air can mislead one into seeing a fracture line. This is a condition where usually the short or long pastern bone has had some trauma to it. The bone's response to the injury is to produce more bone around the injury. This produces a very roughened appearance to what should be a smooth outline of the bone.<sup>6</sup>

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<sup>5</sup> Alan Lipowitz and Charles Newton, "Radiographic Examination," *Degenerative Joint Disease and Traumatic Arthritis*, accessed April 14, 2011, [http://cal.vet.upenn.edu/projects/saortho/chapter\\_87/87mast.htm#radexam](http://cal.vet.upenn.edu/projects/saortho/chapter_87/87mast.htm#radexam).

<sup>6</sup> Equine Medical Service, "Radiographs—Why Bother With Those Pictures?" accessed October 25, 2012, <http://emsvet.com/newsletters/radiographs-why-bother-with-those-pictures/>.



Figure 1. Radiograph of incomplete fracture. (Radiograph courtesy of College of Veterinary Medicine, Cornell University, Ithaca, NY.)

To avoid this confusion, this project aims to render a 3D interpretation of the information contained in x-rays to empower lay people in making better-informed decisions about treatment options for injured horses.

### **Three-Dimensional Computer Graphics**

“The rationale for the use of three-dimensional graphics is that 3D images represent the simulation of three-dimensional space, basically, a simulation of the depth



we see in reality.”<sup>7</sup> We see the world in 3D and this shapes our understanding of what we see. Three-dimensional graphics “bring together many parts to form a greater whole.”<sup>8</sup> Additionally, 3D computer graphics more closely parallel reality, and have become popular as a means of transmitting information. When used to interpret x-ray films, 3D graphics help a layperson understand the nature of an injury without the assistance of a veterinarian.

Color illustrations of the horse’s leg were created by utilizing Autodesk Maya, Adobe Photoshop, and Adobe Illustrator to show fractured legs of various types and possibilities for repair. A diagram of healthy horse legs, without fractures, is in the center of the poster while illustrations of five sets of fractured legs and accompanying repairs surround the diagram. Each bone and repair is identified with labels.

To provide horse owners with a solid visual of fractured bones, models of fractured bones were created in Autodesk Maya with an application of textures from Adobe Photoshop to make the bones look more realistic. Bones were rendered using Autodesk Maya. Autodesk Maya provides a sense of reality by allowing a rendering of all perspectives of a 3D object. This program allows an illustrator to view and sculpt models for an accurate visual representation of a physical object. Images of equine leg bones from the Genesee Valley Equine Clinic’s reference library, texts from the College of Veterinary Medicine at Cornell University, and actual radiographs were used to create illustrations of equine bones in Autodesk Maya.

In my classes, I did not learn how to add texture to the bones I created. Autodesk Maya’s tutorial shows how to add textures for the bones as illustrated for this project, so I challenged myself to create these textures. Maya has several surface attributes that define

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<sup>7</sup> Isaac Victor Kerlow, *The Art of 3D Computer Animation and Effects* (Hoboken, NJ: John Wiley, 2004), 6.

<sup>8</sup> Isaac Victor Kerlow, *The Art of 3D Computer Animation and Effects* (Hoboken, NJ: John Wiley, 2004), 6.

how a surface looks when rendered. I used Blinn, a shading attribute that has a variety of sizes of highlights. I added the bump attribute to give the bones the appearance of physical texture, representing what would be felt if I touched the surface of the bone. I applied a procedural fractal noise texture to create the realistic surface of the bone. However, the textures I applied did not appear realistic, so I utilized Adobe Photoshop to correct the textures. I used Photoshop's Paintbrush tool to smooth the articulating bones, such as the humerus.

### **Case Studies Used in Illustration Development**

#### **Case #1: Broken Right Rear Tibia**

The owner brought a newly adopted thoroughbred horse to her pasture. Her miniature horse, named KIP, was introduced to this new horse who then promptly kicked him, breaking his leg. KIP had a broken right rear tibia, termed a catastrophic fracture by the veterinarians at Cornell University's large animal clinic.

The owner's local veterinarian referred KIP to Cornell for an evaluation and counseled the owner on decisions regarding the broken leg. The owner, who cared deeply for KIP, would not euthanize the horse without input from a veterinary facility known for its ability to care for injured horses. Cornell veterinarians believed that KIP had a very good chance of survival, as he was only six years old with a positive, cooperative attitude. The owner took a chance and allowed the doctors to attempt to repair the fracture through three surgeries at Cornell. Although KIP's leg is not totally sound, healing with a sharp angle just above the hock, he continues to serve as a learning opportunity for others and a joy to his owners.<sup>9</sup>

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<sup>9</sup> Lynn Blank, interview by author, June 25, 2010.



Figure 2. Radiograph of KIP's fractured right rear tibia. (Radiograph courtesy of College of Veterinary Medicine, Cornell University, Ithaca, NY.)

Figure 2 is one of five x-ray films the veterinarian took of KIP's fracture. The tibia is clearly broken, although this film does not offer the same level of clarity as a 3D graphic.



Figure 3. Illustration of fractured tibia by author.

A 3D graphic of the broken tibia as shown on the x-ray was manipulated by creating texture, color, and bumps. The objective was to give owners a visual representation of the tactile surface. A visual tactile sensation of the bone affords the owner a more detailed understanding than x-ray films.



Figure 4. Radiograph of tibia repair. (Radiograph courtesy of College of Veterinary Medicine, Cornell University, Ithaca, NY.)



Figure 5. Illustration of tibia repair by author.

## **Case #2: Metatarsal and Humerus Fractures**

The second case involves a horse named Ruffy, which was involved in a kicking fight with another horse in a pasture. The first injury involved a draft-cross horse kicking him, hind end to hind end. The left hind was injured. In the second injury, the same horse kicked Ruffy in the left front shoulder, fracturing his humerus. Both injuries were x-rayed to help decide treatment options.

With the first injury, Ruffy's leg was repaired with bandages and time off. The fracture was in the center-core of the left hind splint bone (metatarsal), a non-weight bearing bone and easily repaired without surgery. After a long rest, he went back to work and successfully competed at training events.

With Ruffy's second injury, the owner wanted the doctor to fix the fracture no matter what the cost, if it could be done. Ruffy was not bearing weight on the left foreleg and the x-rays showed a comminuted fracture. The veterinarian said the fracture was so devastating that repair was not possible, and the decision was made to euthanize Ruffy.<sup>10</sup>

X-rays from Ruffy's first case did not reveal fractures to an untrained eye. Dr. Celeste Boatwright, of the Genessee Valley Equine Clinic in Scottsville, New York, showed where the fracture was by putting the film on a special lightbox designed to help read x-rays. Even with the assistance of the light box, fractures were difficult to detect on the x-ray. Such x-rays may stress owners because they do not show the severity of the injury or offer the owner the means of tangibly understanding the nature of the injury.

In his first injury, Ruffy had an incomplete fracture on the metatarsal bone, which meant the fracture started on one side of the bone but the bone did not completely break.

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<sup>10</sup> Anne Ambrosini, interview by author, August 18, 2010.



Figure 6. Radiograph of incomplete fracture. (Radiograph courtesy of Genesee Valley Equine Clinic, Scottsville, NY.)



The 3D illustration of Ruffy's injury (fig. 7) demonstrates why a veterinarian's intervention was unnecessary by clearly showing the location and extent of the fracture.



Figure 7. Illustration of incomplete fracture by author.

The 3D illustration in figure 8 shows Ruffy's healed bone.



Figure 8. Illustration of healed incomplete fracture by author.

When Ruffy sustained his second injury, the veterinarian took three x-ray films. The first two films do not clearly show the position and nature of the fractures. The last film is a bit clearer but not illustrative enough of the extent of damage sustained. This fracture was a comminuted fracture, which meant the fracture broke the bone into several pieces. The humerus connects the shoulder to the elbow in the foreleg, and repair was not possible without damaging the nerve.



Figure 9. First radiograph of Ruffy's comminuted fractured humerus. (Radiograph courtesy of Genesee Valley Equine Clinic, Scottsville, NY.)

ID: 7572 Patient: Ruffy  
Sex: M DOB: 1991/01/01  
Date: 04.25.2007 12:38:45  
Left Shoulder Greater Troch. Obl

Genesee Valley Equine Clinic, LLC  
Eklin EDR3 MkII Portable Digital Radiography System  
SID:207 HUTTEN CL



Figure 10. Second radiograph of Ruffy's comminuted fractured humerus. (Radiograph courtesy of Genesee Valley Equine Clinic, Scottsville, NY.)



Figure 11. Third radiograph of Ruffy's comminuted fractured humerus. (Radiograph courtesy of Genesee Valley Equine Clinic, Scottsville, NY.)

The 3D rendering of the x-ray film of Ruffy's second injury shows the location and extent of the fracture, which was major. The severity of this fracture persuaded the owner to euthanize the horse.



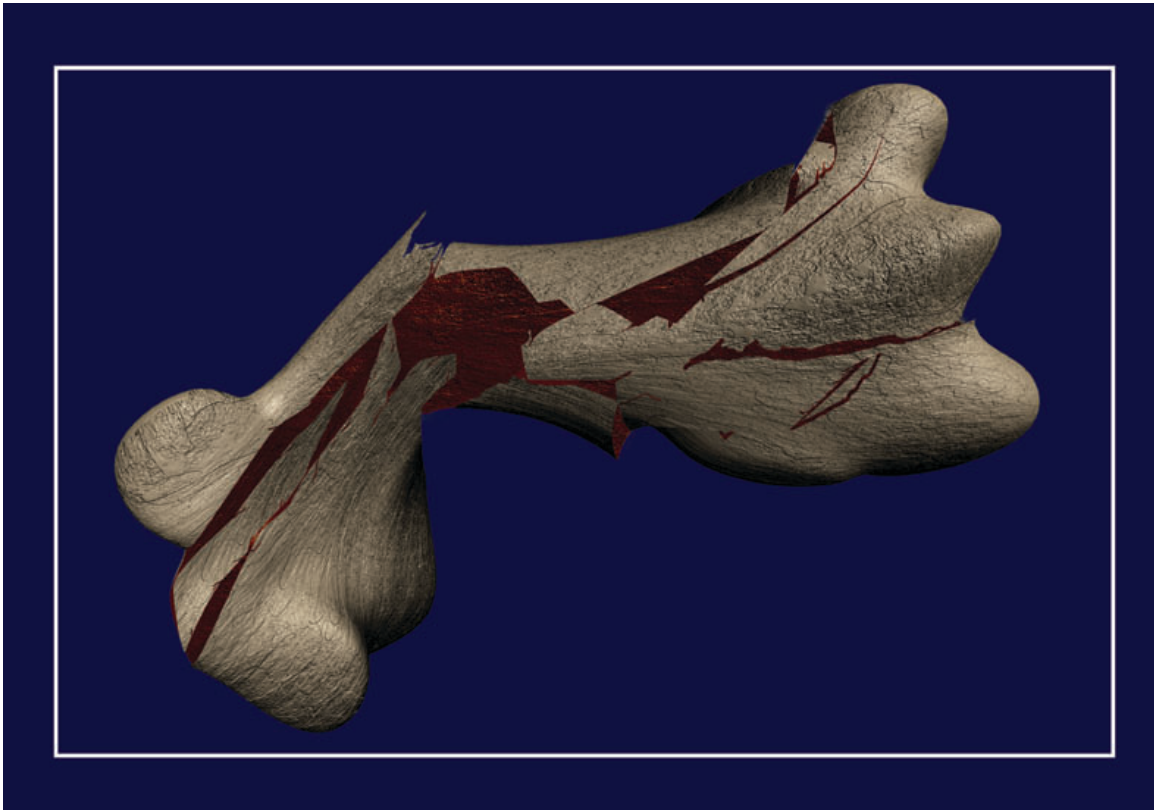


Figure 12. Illustration of Ruffy's comminuted fractured humerus by author.

### **Case #3: Comminuted Fracture of the Long Pastern**

Dr. Boatwright shared the case of an unnamed patient with a comminuted fracture of the long pastern. Comminuted fractures usually happen due to the torque from the end of the cannon bone, which acts like a screwdriver driving it into the long pastern, which acts like the screw, creating a lot of torque on the bone.



Figure 13. Radiograph of comminuted fractured long pastern. (Radiograph courtesy of Genesee Valley Equine Clinic, Scottsville, NY.)

At first glance, this seemed to be a fracture that could be repaired through the use of screw fixation by taking a piece of bone, pressing it against the parent bone, and stabilizing the bone with screws. Dr. Boatwright clarified the severity of the injury and insufficiency of this repair by pointing out that pieces of the bone were shattered like a bag of crushed ice. The x-ray film does not reveal this degree of injury.

The 3D illustration in figure 14 magnifies the level of the injury by showing the extent of the injuries akin to a bag of crushed ice. This level of injury, once made clear to the owner, persuaded the owner to euthanize the horse.



Figure 14. Illustration of comminuted fractured phalanx by author.

### **Purpose of the Posters and Explanation of Their Design**

Adobe Illustrator was employed to create a layout for the poster. The first poster included four images of selected fractures in a landscape orientation:

- One outline of a horse with two 3D models (forelimb and hind limb) with parts of the legs labeled;
- Two images of repairable fractures and two images of fractures that suggest the need to euthanize.



Dark blue was chosen for the background color of the posters to draw attention to the horse's outline. A horse owner, after the potential emotional and financial trauma of a horse injury, would likely benefit from the psychologically calming effect of the color blue."<sup>11</sup>

The contours of the horse's body are outlined in white to serve as reference for the bones' locations. White was chosen as a contrast to the dark blue background, drawing attention to the horse. The details of the horse's body are not necessary, keeping the focus on the leg bones.

Regular Arial type, a common sans serif font, provides clean lines in contrast to the illustration. The font is at 32 point to label each bone, making the labels readable from a distance as well as close up. Labeling the bones benefits the veterinarian and trainer by highlighting reference points when describing the horse's injury.

The horizontal layout, shown in figure 15 provides owners with a good overall view.

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<sup>11</sup> Zena O' Conner, "Colour Psychology and Colour Therapy: Caveat Emptor," *Color Research and Application* 36, no. 3 (2011): 231.

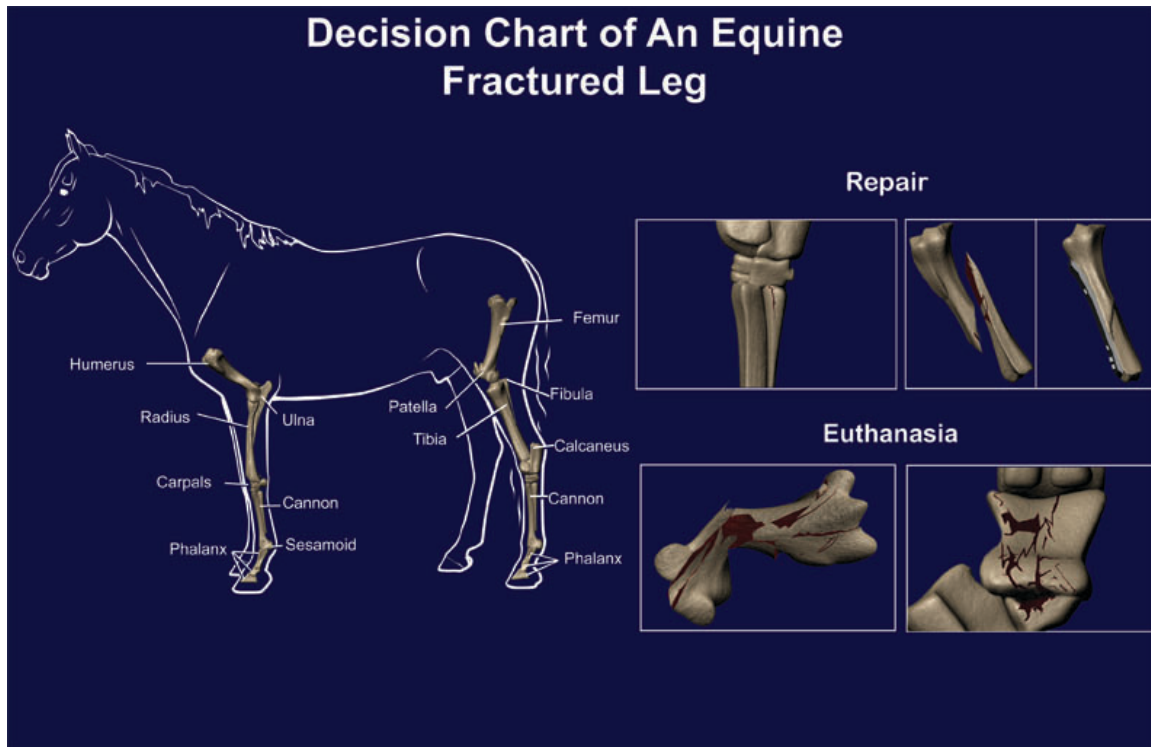


Figure 15. First poster developed by author.

In the first poster, figure 15, the forelimb and hindlimb do not appear balanced. There is an element missing. After consultation with Professor Glen Hintz, the scapula and ilium were added to the illustration. Those parts were faded to show that they were not a part of the leg, but contributed to the overall horse outline by balancing the forelimb and hindlimb. Additionally, metacarpals and metatarsals were labeled with correct medical terminology; beneath that, in parentheses and italic type, are the common words used by veterinarians and owners.

There needed to be a way to show which fractures had a poor prognosis and which ones had the potential for repair, because “not all fractures carry a grim prognosis. All are different, and some are more repairable than others,”<sup>12</sup> and “bones in different

<sup>12</sup> Sharon Biggs, “Broken Legs Aren’t Death,” *Blood-Horse*, accessed April 12, 2011, <http://www.bloodhorse.com/horse-racing/articles/33663/broken-legs-arent-death>.

areas of the leg have different degrees of success when it comes to healings.”<sup>13</sup> This was discussed with Dr. Boatwright, who explained fractures and how they relate to prognosis. She recommended changing the title from “Decision Chart of An Equine Fractured Leg” to “Prognosis of Equine Limb Fractures Based on Type and Location,” since she believes the term *prognosis* is more appropriate than *decision chart*, in that it is not as definitive. In adult or large horses, fractures above the carpus and tarsus generally carry a poor prognosis.

To illustrate this distinction, red lines were added to the next revision around the areas where fractures are likely to carry a poor prognosis. The result, shown in figure 16, was a poster that appeared crowded.

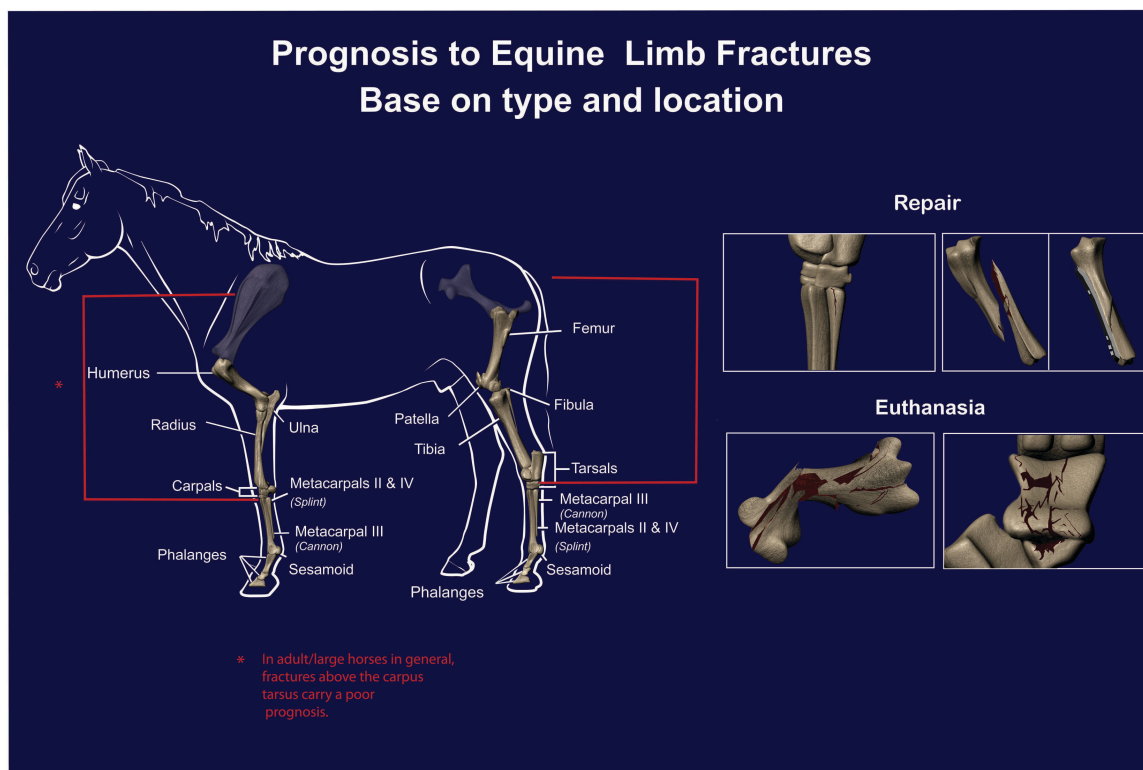


Figure 16. Second poster developed by author.

<sup>13</sup> Jessika Toothman, “Do Horses with Broken Legs Have to Be Shot?” *HowStuffWorks.com*, accessed April 26, 2011, <http://animals.howstuffworks.com/mammals/broken-leg-horse1.htm>.

To reduce crowding in the poster, Professor Jim Perkins suggested changing the layout from landscape to portrait. Bones shown in the detailed pictures of the broken or repaired bones were labeled with capital letters to enhance connection between the images. Figure 17, compared to figure 16, shows the four examples of fractured bones in a neater and more organized fashion.

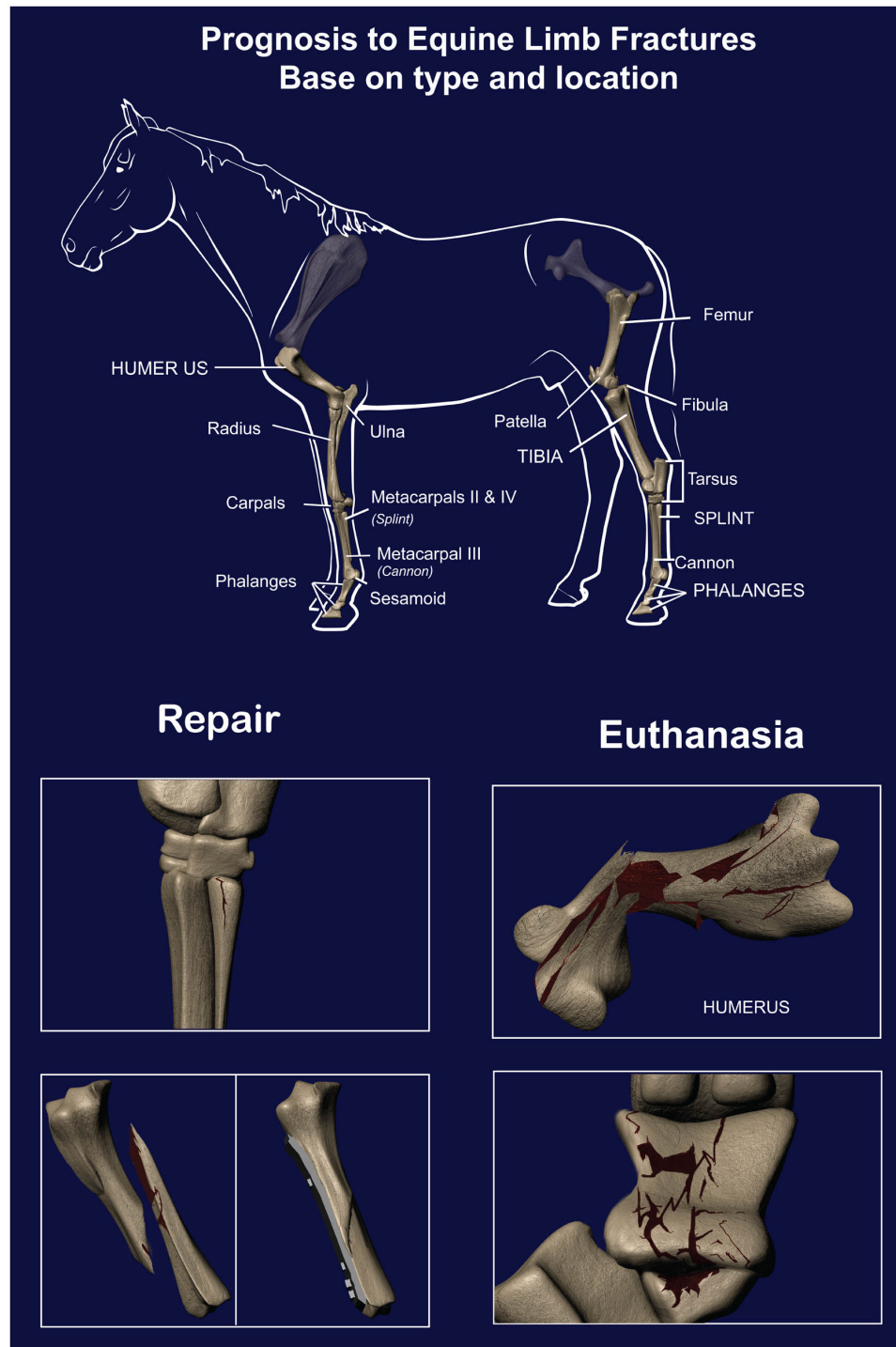
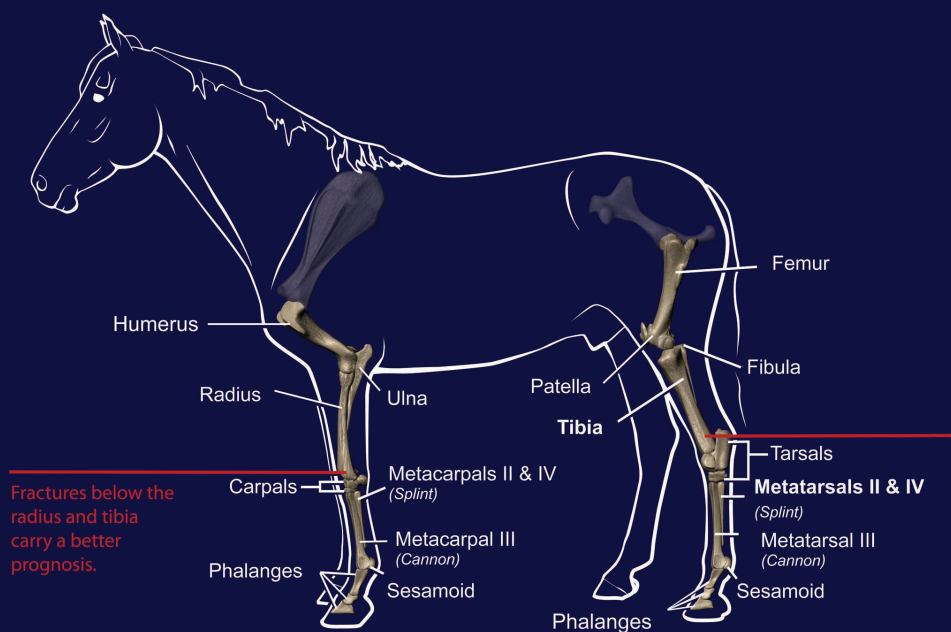


Figure 17. Third poster developed by author.

Figure 17 still did not offer enough clarity regarding the types of fractures and the treatment options available. The prognosis depends upon which bones are injured and

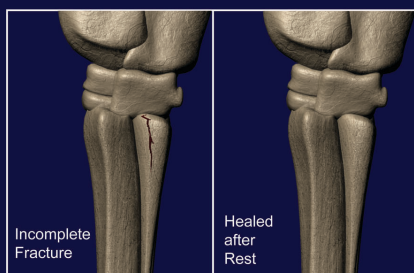
their location, and as a result leg fracture repairs have different degrees of success and failure. However, having both illustrations on the same poster was overwhelming. The repair and euthanasia illustrations needed to be visually separate to aid the owner's comprehension and decision-making. Thus, two posters were created: one for repair and the other for euthanasia. Each poster has a red line with the prognosis, giving the owners a quick visualization of the horse's future. Each poster includes definitions of fractured bones, and two cases that are related to the topic with a brief patient history and the injury sustained. The labels for bones shown in the two fracture illustrations are bolded to help the owner make a connection between the name and the bone referenced.

# Prognosis of Equine Limb Fractures Based on Type and Location



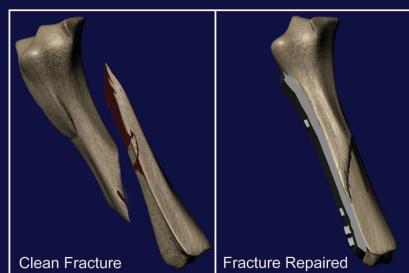
## Repair

Incomplete Fracture- starts on one side of the bone but does not break completely through it.



Patient: Adult Horse  
Location of Fracture: Metatarsal  
Repair: Rest

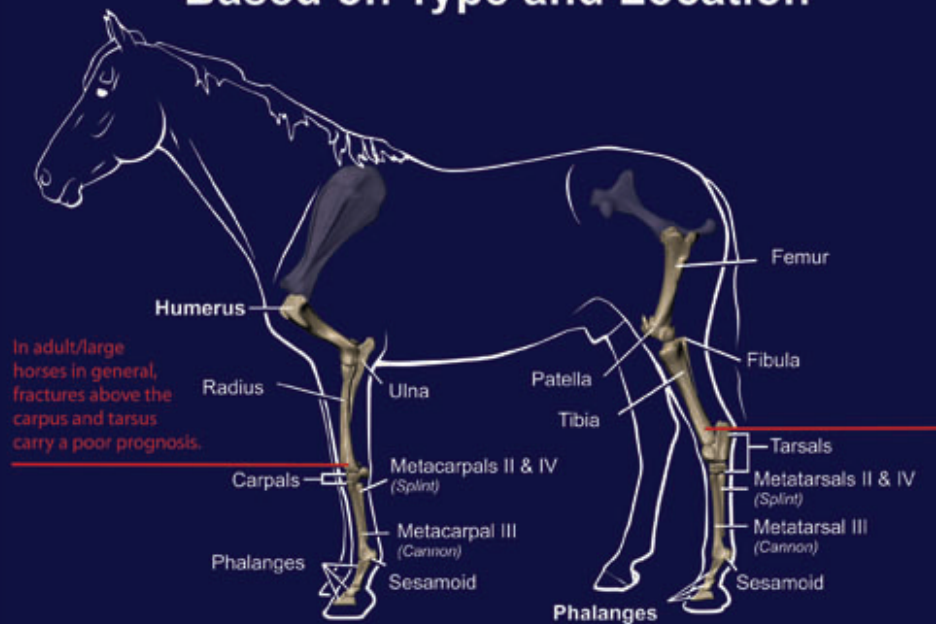
Complete Fracture- breaks the bone into two or more pieces



Patient: Miniature Horse  
Location of Fracture: Tibia  
Repair: Metal plate and screws

Figure 18. Poster for repairable fractures developed by author.

## Prognosis of Equine Limb Fractures Based on Type and Location

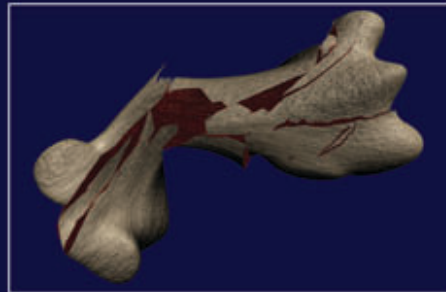


### Euthanasia

Comminuted Fracture - breaks the bone into several pieces; sometimes the broken pieces are spread apart.



Patient: Adult Horse  
Location of Fracture: Phalanx



Patient: Adult Horse  
Location of Fracture: Humerus

Figure 19. Poster for fractures indicating euthanasia is recommended, developed by author.



The two posters present a visual, highly-detailed explanation to lay people empowering them to make informed decisions regarding treatment options.

### **Conclusion**

The posters shown in figure 18 and figure 19 were printed onto paper with a matte finish that was then mounted on a piece of foamcore for support. The 34" x 46" posters were installed at the Rochester Institute of Technology's Bevier Gallery. Graduate students, friends, and family were invited to attend the opening. These posters were on display for one quarter, approximately 11 weeks. Visitors came to view the work displayed, and I answered their questions. Visitors with no knowledge of equine anatomy showed interest in these posters and appeared to understand the information presented. This gallery showing revealed that non-medical professionals were able to utilize and understand those illustrations.

The next step is to continue working on 3D models, not just of the forelimb and hind limb, but also of the entire equine anatomy. Future work also includes the creation of a few animations of a horse in motion with the bones clearly illustrated to show how they work together as well as illustrations of how the body is affected by a fractured leg.

Many professionals were consulted for this thesis. They each made suggestions that strengthened the end product. Especially helpful was Dr. Boatwright, an expert in horse anatomy, bone structure, and repair. She also provided the correct veterinary vocabulary to lend credibility and accuracy to this work. The faculty in the Medical Illustration program were also helpful in making important recommendations in terms of design principles and readability.

I learned a great deal about horses and the types of fractures they can experience. I did not know that fractures above the carpus and tarsus carry a poor prognosis, while fractures below the radius and tibia carry a better prognosis. Furthermore, I learned how to work with texturing tools in two different software programs, through Maya tutorials

and prior knowledge of Photoshop. Working with these software programs provided an opportunity to challenge myself and to create clearer images of the horse's leg structure.

As a horse owner, I understand how difficult making decisions regarding an injured horse can be. Having 3D illustrations of a fractured/broken leg along with clearly illustrated options for treatment would provide a deeper understanding of the problem and allow better-informed decisions regarding care than using only x-rays as a guide.

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